Volume 9, Issue 5, May – 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2176

Catfish (*Pangasius sp.*) Sausage Processing on Physical-Chemical and Microstructure Characters

Happy Nursyam[1*]
[1]Faculty of Fisheries and Marine Science, Universitas Brawijaya. Malang, Indonesia

Abstract:- This study aimed was to obtain the best concentration of the catfis (Pangasius sp.) in replacing beef in sausage processing. Factors and variables used was the proportion of beef on catfish meat (w/w), namely: 100; 75; 50; 25; and 0 %. The parameters observed included: moistur, protein, fat, and ash content, as well as color (L, a*, b*), and microstructures by using SEM. The results showed that catfish meat could replace up to 25% beef make processing of sausage having 58.94±0.34 % moisture content; 12.05±0.29% protein content; 19.4±0.17 % fat content; and 3.35±0.119% ash conten. Color performance expressed as L, a*, and b* value were 47.9±1.31; 22.13±1.76; and 13.50±0.8 respectively. The results of SEM observation showed that the sausage with 50 % beef and fish ratio had a more compact microstructure than the others, a smoother cavity , miofibril threads and form a smooth swollen.

Keywords:- *Beef, Meat Catfish, Sausage, Fortification, Microstructure, Miofibril, AndSwollen.*

I. INTRODUCTION

Fish sausage is a product, where fresh fish meat is mixed with several additional ingredients, then put into a casing and processed through heating (Chuopouhuk, et al., 2001). Fish sausage processing began to develop rapidly in Japan from 1950 to 1975, and is a development of the kamaboko industry (Okada, 1992). A very important component of meat in making sausages is protein. Meat protein plays a role in increasing the breakdown of meat during cooking to form a compact product structure. Another role of protein is in the formation of meat emulsions, namely proteins that function as fat emulsifiers (Nursyam et al., 2007). Emulsions from beef fat tend to be more stable because beef fat contains more saturated fatty acids. Cooked sausages should contain no more than 30% fat.

The characteristics of fish meat are different from beef or chicken. Fish meat has a softer texture, so the sausage produced is different from sausages known to the public; therefore, it is necessary to add beef so that the texture of the sausage is softer. According to Chuopouhuk, et al. (2001), to unify sausage components, strengthen color and deactivate microbes, was cooking by steaming. In addition, steaming will increase or decrease the softness of the sausages depending on the temperature, cooking time and type of meat.

Sausage is a semi-wet food product, which is generally stored at low temperatures to prevent damage due to microorganism activity. The use of catfish in sausage processing as a substitute for beef is not only to increase the value and usefulness of catfish, but also to increase the character of sausage emulsion, because fish protein has more fibrous properties than livestock meat. The purpose of this study was to obtain the best comparison between beef and catfish on the physico-chemical and microstructure-properties of sausages processed by the steaming method.

II. MATERIAL AND METHOD

A. Raw Materials And Supporting Materials

The raw materials used are beef loins obtained from traders in Malang-East Java, and catfish from breeders in Batu city, East Java. The ingredients for making sausages and their supporting materials include: water, tapioca flour, cooking oil, carrageenan, fine salt, sugar, powdered pepper, garlic powder, and collagen casing obtained from a large market in Malang-East Java. The analytical materials consisted of concentrated H2SO4, kjeldahl tablets, distilled water, PP indicators, concentrated NaOH indicators, H3BO3, MO, and Hexan solvents from the Laboratory of Fisheries Product Technology, Faculty of Fisheries and Marine Sciences, Brawijaya University.

B. Chemical Analysis

Analysis of water content using the evaporation method in an oven at 100 ºC, protein content using the Kejdahl method, dissolving fat in ether, and ash using a muffle furnace (AOAC, 1984). Sausage color was measured using a MINOLTA CR200b (Minolta, Co., Ltd., Osaka 541, Japan) spectrocolorimeter which was expressed as L (light), a* (reddish) and b* (yellowish) values.

C. Microstructural Analysis

Microstructural conditions were analyzed using SEM (scanning electron microscopy). Sausage samples were put in a 2% Glutaraldehyde fixation solution for 2-3hours at 4 °C, then with a phosphate buffer pH 7.4 for 5 minutes at 4 °C and repeated three times. The next step is to immerse it in post-fixation solution (1% osmat acid) for 1-2 hours at4 °C, then wash it off with a phosphate buffer solution pH 7.4 for 5 minutes at 4 ° C and repeat three times. Dehydration using graded alcohol, namely: 30, 50, 70, 80, 90% absolute 2 times, each for 15-20 minutes. Dehydration using alcohol 30, 50, and 70% was carried out at4 ° C, while at 80 and 90% it was carried out at room temperature. The final step is drying using a Critical Point Drying (CPD) tool, then affixing it to the stub using a special glue. Observe and take photos.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2176

D. Data Analysis

Data were analyzed descriptively using Microsoft Excel, and presented as means of 3 independent variables with standard deviation (SD). The treatment variable was the ratio of beef to catfish (w/w), namely: A = 100; B = 75; C = 50; D = 25; and E = 0%. Determinationof the best treatment using De Garmo analysis.

III. RESULTS AND DISCUSSION

The results of research on substitution of beef with catfish on moisture, protein, fatand ash content are in Table 1, while the best treatment analysis is in Table 2.

Table 1: Research Results of Steamed Sausage

Proportion Beef against catfish (%)	**Content (% db)**			
	Water	**Protein**	**Fat**	**Ash**
100	58.43±0.43	11.93±0.81	19.70±0.19	2.26±0.06
75	58.94±0.34	12.05±0.29	19.40±0.17	3.35±0.11
50	58.93±0.84	13.72±0.21	17.89±0.02	3.18±0.01
25	59.30±0.49	13.95±0.14	17.54±0.23	2.79±0.40
0	63.30±2.36	13.96±0.14	17.50±0.17	2.65±0.11

Table 2: Effectiness Calculation Results (De Garmo)

Content (% db)	**Comparison of Beef:catfish (w/w)**				
	100	**75**	**50**	**25**	**0**
	Effectiveness Value				
Water	0.04	0.04	0.04	0.04	0.19
Protein	0.00	0.01	0.38	0.21	0.01
Fat	0.20	0.17	0.03	0.00	0.00
Ash	0.00	0.20	0.17	0.10	0.07
Color	0.01	0.10	0.00	0.07	0.20
TOTAL	0.25	0.61 *)	0.60	0.41	0.47

Note: *) The best treatment

The results of the best treatment analysis (Table 2) showed that treatment with a ratio of beef to catfish 75% or treatment B was the most preferred sausage by the panelists, with a moisture content value of 58.94 ± 0.34%; protein 12.05 ± 0.29%; fat content 19.4 ± 0.17%; ash content 3.35 ± 0.199%; for the value L * 47.9 ± 1.31; a * is 22.13 ± 1.76; b * is 13.50 ± 0.8. This fact shows that the substitution of catfish to beef up to 25% provides the most suitable physical-chemical characteristics for panelists, because it is suspected that in this treatment the role of protein as emulsifier of fat and water is an ideal condition for steamed sausages.

Emulsion is a two-phase system consisting of two immiscible mixtures, one of which is dispersed with the other. According to Lenah (1995), in the fish meat sausage emulsion system, the protein that most acts as an emulsifier is salt soluble protein and water soluble protein. The salt-soluble protein in fish meat is myofibril protein consisting of actin, myosin, and actomyosin. In a meat emulsion, each lump of fat is covered by dissolved meat protein. Protein forms a matrix that covers the fat grains, so that the fat grains do not easily escape from the system.

Emulsifier is a dough emulsifier. The dough added with the emulsifier will be more stable, easy to expand, very evenly mixed, not too liquid and not too dense, not easily changed due to environmental influences. Suzuki (1982) explains that an emulsifier is a material that can reduce the surface tension between two phases under normal conditions. A good emulsion requires a third material capable of forming a membrane around the scattered granules to stabilize the emulsion stability (Hand et al., 1992).

Emulsification of sausage occurs by mixing two different phases, namely water and fat, which when mixed with an emulsifying agent can form a stable mixed combination (Chuopouhuk, *et al.*, 2001). The addition of fat as a dispersed phase in the sausage-making process aims to obtain a compact sausage product, a soft texture and a better sausage taste andaroma (Smith, 1988). Whereas water as the dispersing phase functions to dissolve sarcoplasmic protein (water-soluble protein) and as a salt solvent that will dissolve myofibril protein (salt soluble protein) (Rossa and Incze, 1990). Type of raw material, cooking temperature, cooking time, seasoning, and preservation (Kuo and Chu, 2002) influences sausage color. Graphs of the mean color change (L*, a*, and b*) are shown in Figures 1 to 3.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2176

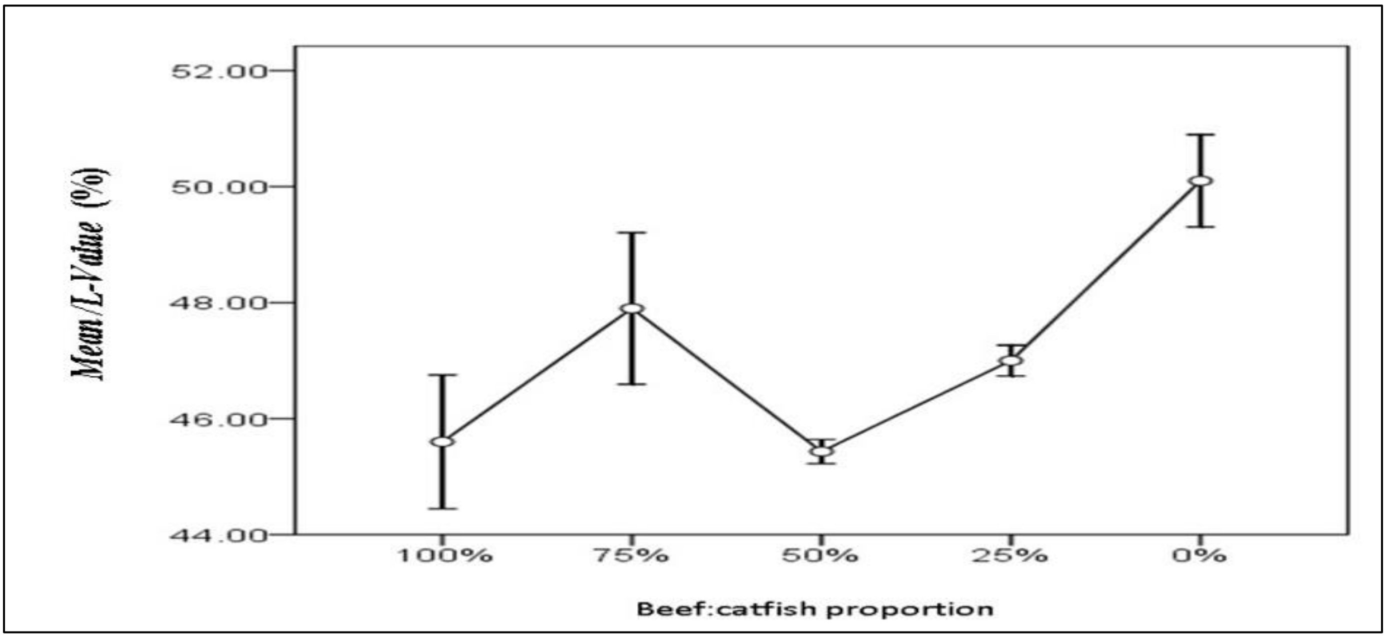

Fig 1: Graph of the Proportion of Catfish and Beef Meat to the Color Value of l*Steamed Sausage

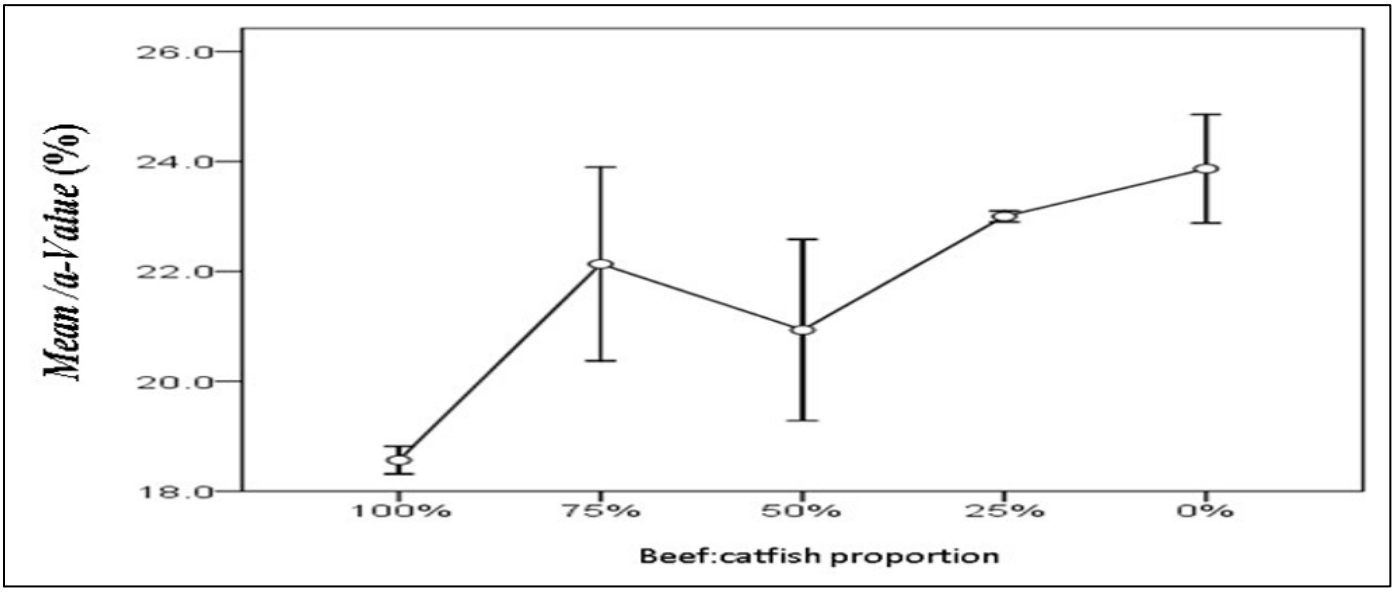

Fig 2: Graph of the Proportion of Catfish and Beef Meat to the Color Value of a*Steamed Sausage

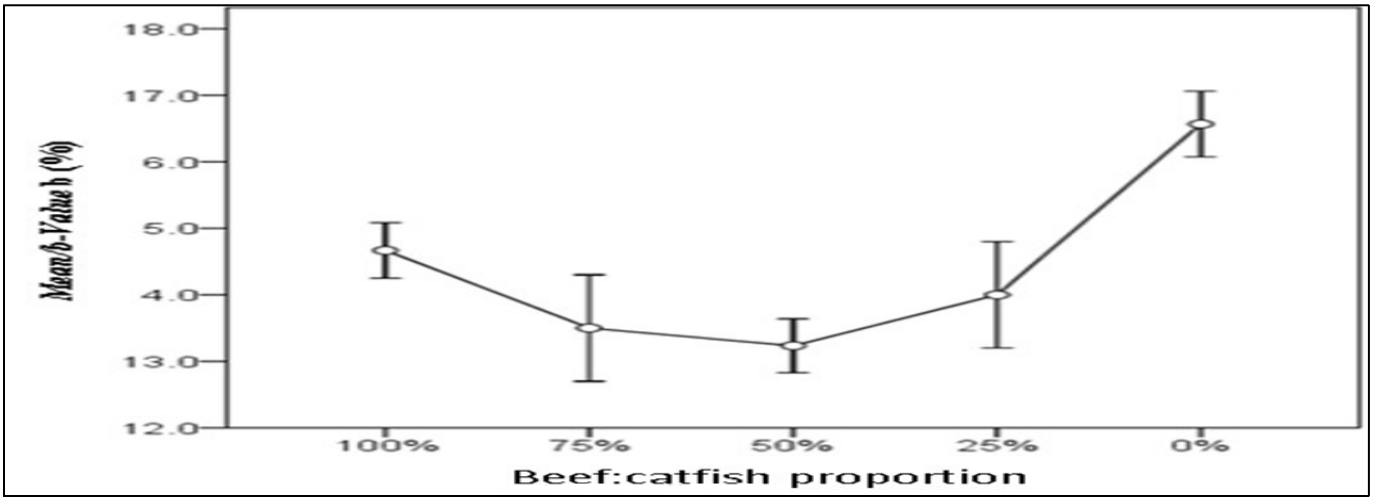

Fig 3: Graph of the Relationship between the Proportion of Catfish and Beef to the Color of b * Steamed Sausage.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2176

Figures 1 to 3 show that the highest white (L), reddish (a*), and yellowish (b*) colors in sausages with beef substitution by catfish meat were 0% (treatment E). This relatedto the protein content of the sausage, where the higher the protein content, the less coagulated protein percentage will be, and the color will be whiter. According to Lien et al. (2002) the more denatured protein, the reddish color becomes faded (less redness), soft, and whiter. Laack and Kaufman (1999) also reported that protein denaturation in pork loin sausage had higher L values. Hughes et al. (2001) stated that the more the concentration of myofibril denatured acetic acid, the less it was. This phenomenon indicates that (L) is important information for protein changes during the sausage cooking process. The increase in value(a*) is due to the decrease in value (L) due to the higher denaturation of myofibrils protein (Ferreira et al., 1994). The values (a*) of experimental sausages were 18.57 ± 0.25 - 23.87 ± 0.99 (Table 1) higher than those of salami (5.68–8.90) (Dellaglio et al., 1996), and Spanish sausages (5.39- 0.84) (Gariga *et al*., 1996). This situation is advantageous, because more denatured protein makes the product easier to digest.

The high yellowish (b*) value is due to the lower myoglobin content of catfish than beef, so that the more catfish meat substitutions reduce the reddish color to yellow. Rosa *et al*.(1990) stated that the pigment in muscle tissue associated with color is the blood pigment hemoglobin, especially in the bloodstream, and myoglobin contained in cells. Winarno (2004)explained that the myoglobin molecule consists of two parts, namely: the protein (globin) and the non-protein (heme) part. Furthermore, it has stated that the myoglobin content in each meat is different depending on the type. The main cause between white meat and red meat is the pigment content, where myoglobin is the main pigment found in red meat. The color of the sausage at the end of ripening depends on the myoglobin level of the raw material. Sausages from this study have a white (L) and yellowish (b*) color and lower redness (a*) when compared to salami (Dellaglio et al. (1996), but are similar when compared to sausages in China (Kuo and Chu, 2002) The color of processed meat products is an implied reaction of the formation of nitrous heme pigments (NHP) from heme pigments (HP) present in raw materials, and affects the color of the final product (Gimeno *et al*., 1999).

The results of the microstructure analysis of the best-treated sausages compared to 100% beef (A) and 100% catfish (C) sausage has shown in Figure 4.

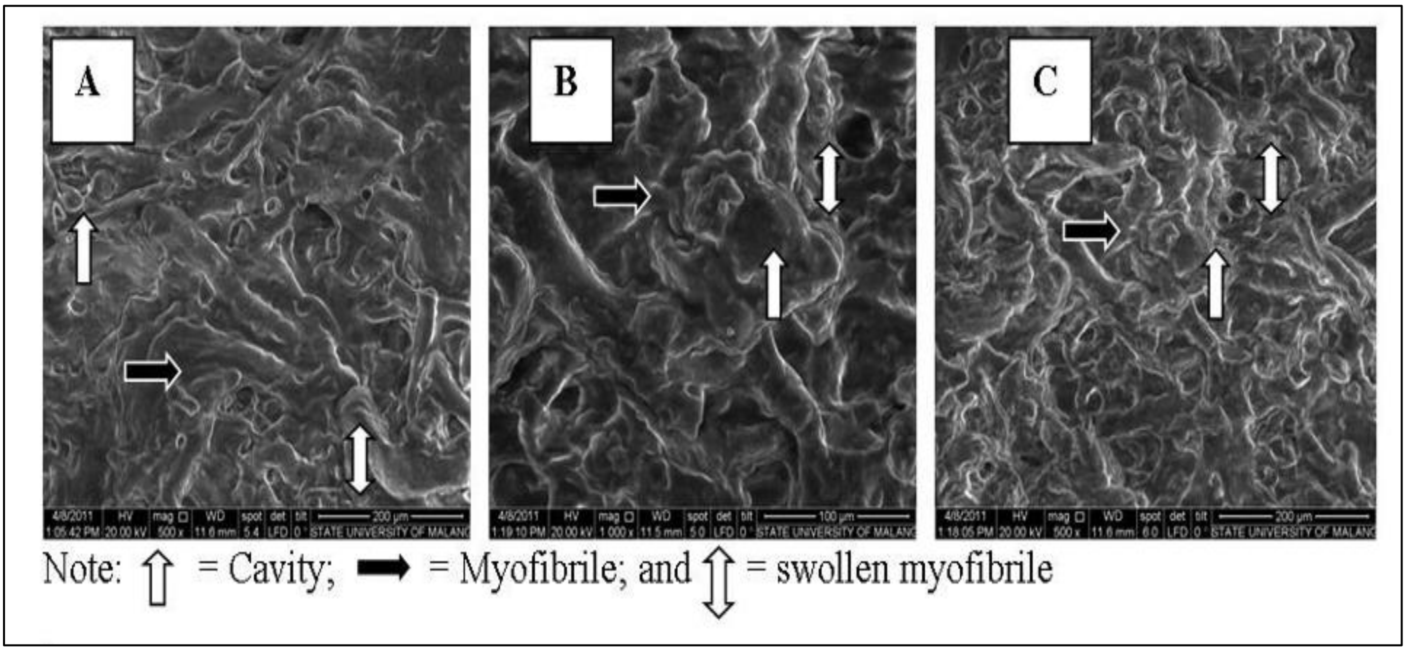

Fig 4: SEM photos of Steamed Sausage (Magnification 500x). A = 100: 0; B = 75:25; C = 0: 100.

Figure 4. The microstructure of all sausages contains myosin threads that are almost the same as each other. Myosin threads that arise in all forms of sausage caused by damage to fish tissue cells due to chopping, so that the opening of the sarcolema from myofibrils damages their integrity. The actomyosin threads in the sarcomere, and increase the electrostatic chargeof the protein have absorbed Cl ions from salt added to minced meat. Harford *et al*. (1991) stated that the decrease in ATP due to glycolysis reduces the junction in the sarcomere, and a number of acids penetrate into the myofibrils and extract globulin proteins.

Figure 4A shows that a sausage containing 100% small threads dominate beef. The tiny threads are thought to be triple helical collagen, as tropocolagen molecules that form fibrils. The reduction in fibril formation is thought to be due to less salt-soluble and water- soluble protein in beef extracted from sarcolema than catfish, and consequently, the heat energy generated during the cooking process is lower and the hydroxyproline is unable to break down. of the triple helical structure. Rose and Mandal (1996) stated that the enthalpy of collagen depends on the transition to hydroxyproline and hydroxylamine, and the higher the enthalpy the stronger the amino acid bonds in collagen. Theno *et al.* (1978) stated that the presence of fine threads in sausages proved to be very little dissolved and extracted protein. Balian and Bowes (1977); and Kimura and Ohno (1987) stated that the stability of hydroxyproline depends on heat stability, and affects the stability of collagen. Hand *et al*. (1992) stated that the number of myofibril threads that was extended could increase the bond stability and protein coagulation. Suzuki (1981) states that the release of water molecules from the sausage causes the protein molecules to approach each other and form various cross- links. Katsaras & Budras (1992) stated that water functions as a hydration layer that separates a group of protein aggregates, and holds them together through hydrogen bonds.

Figure 4B shows that the structure of a sausage is in the form of a smaller cavity and has more grain and is denser than a sausage with 100% beef or 100% catfish. Cavity size is associated with reduced salt penetration into the myofibril threads, so that less protein extracted. The formation of cavities and rough structures indicates the remaining tissue of actomyosin from myofibril tissue has not extracted. This phenomenon causes the fat to leave the emulsion structure and occupy the empty space between the surfaces of the protein layer due to the shrinkage effect during incubation. The visible granules derived from myofibril proteins and the intercellular matrix in myofibrils. Smith (1988) states that the presence of cavities in sausage products causes the emulsification of fat to become unstable, and the size of the cavities formed depends on theliquefied fat from the protein emulsion matrix. Woloszyn (2002) states that myofibril protein and stromal protein play o role in the formation of fermented sausage gel. The ability of protein gel formation directly related to myosin, and number of actin (Asghae *et al*., 1984; Morita *et al*., 1987). Regulatory proteins (Joandel *et al*., 1984), sarcoplasmic proteins (Morioka and Shimizu, 1992) pH and ionic strength (Farouk *et al*., 1999).

Figure 4C shows that the sausage combination of 75% beef and 25 catfish (Treatment B) dominated by swollen myofibrils that are wider and more compact than other sausages (Figures 4A and 4B). This situation though related to the high content of bi-acidic and biacid collagen, but it does not contain tryptophan and cysteine. Result of this special and fewer amino structures compared to these myofibrils, there are only a few cross-links betweenthe chains and collagen easily swells in an acidic or alkaline environment. As a result, collagen, which is non-polar, turns into gelatin that is polar, and increases the coagulation of myofibril proteins, and proteins dissolved in the coagulation process affect the structure of themyosin bonds. Katsaras and Leistner (1988) stated that the amount of dissolved protein increases the formation of swollen. The combination of 75% beef sausage and 25 catfish meat(Treatment B) which was different from 100% beef sausage and 100% catfish meat caused by the entry of myosin protein gelation into the system, due to the very small amount of actomyosin aggregate that was degraded during cooking. Visessanguan *et al*. (2000) reported that the formation of actomyosin gel by cathepsin L could interfere with the initial gel formation structure that formed, besides that there is a decrease in the strength of the cross-link between the small aggregates of actomyosin.

Furthermore, sausages with 100% beef and 100% catfish (Figures 4-A and 4B)showed a number of broken myosin threads. The fracture of myosin strands shows that actininteracts with myosin as actinomyosin released in the gel unity. Vissesanguan *et al*. (2000)reported that myosin and actomyosin play an important role in the formation of gel entities.Myosin is a protein that has the ability to form gels, while actin is associated with skeletalprotein regulation, and does not form gel, but affects viscoelasticity (Ramírez *et al*., 2000). Acton *et al*. (1983) stated that emulsification based on the properties and stability of myosin and actomyosin in myofibrils, and that myosin can be absorbed in the emulsion system.Woloszyn (2002), reported that protein gel becomes coarse because the protein matrix is bound between myosin fibers. Jeacocke (1977) states that an increase in temperature causesthe protein wrap between the fat globules to become thin, which leads to a decrease in thestability of the emulsion in sausages.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

Catfish meat is able to replace up to 25% of beef in the processing of steamed sausages. The chemical characteristics of the sausages are water content of 58.94 ± 0.34%; protein of 12.05 ± 0.29%; fat content of 19.4 ± 0.17%; ash content of 3.35 ± 0.11 9%; for L * value of 47.9 ± 1.31; a * is 22.13 ± 1.76; b * is 13.50 ± 0.8. The SEM test results showed that sausages with a 50% proportion of beef showed a more compact microstructure and finer cavities.

B. Suggestion

Based on De-Garmo's analysis, it is necessary to carry out further research on the range of beef 50 to 75%, in order to obtain the most appropriate proportion.

REFERENCES

[1]. Acton, J.C., Ziegler, R.G. and Burge, D.L. Jr. 1983. Functionality of muscle constituents in the processing of comminuted meat products. *CRC Critical Reviews in Food Science and Nutrition* 18: 99-121.
[2]. Asghar, A., J. I. Morita, K. Samejima and T. Yasui, 1984: Biochemical and functional characteristics of myosin from red and white muscles of chicken as influenced by nutritional stress. *Agric. Biol. Chem.* 48: 2217–2224.
[3]. Balian, G., and Bowes, J. H., 1977. The structure and properties of collagen. In A. G. Ward,& A. Courts (Eds.), *The science and technology of gelatin.* p. 1–30.
[4]. Choupoehuk,P., N. Raksakulthai, and Worawattanamateekul, 2001. Process Development of Fish Sausage. *Int. Journal of Food Properties.* 4 (3): 523 – 529.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24MAY2176

[5]. Dellaglio, S., Casiraghi, E., and Pompei, C.1996. Chemical, physical and sensory attributes for the characterization of an Italian dry-cured sausage. *Meat Sci.* 42: 25–35.

[6]. Demeyer, D. I., Vandekerckhove, P., and Moermans, R. 1995.. Compounds determining pHin dry sausage. *Meat Science,* 3, 161-167.

[7]. Farouk, M. M., G. A. Wild, G. A. Mac Donald, K. Wieliczko, R. Lim, S. Turnwald and C. Mudford, 1999. Sarcoplasmic proteins may determine the deformability of cookedsausage batter. *Proceeding of 45th International Congress of Meat and Technology*, Yokohama Japan, 306–307.

[8]. Garriga, M., Hugas, M., Aymerich, T., Montfort, J.M., 1993. Bacteriocinogenic activity of *lactobacilli* from fermented sausages. *J. Appl. Bacteriol*. 75, 142–148.

[9]. Gimeno, O., Astiasaran, I., and Bello, J. 1999.. Influence of partial replacement of NaCl with KCl and CaCl2 on texture and colour of dry fermented sausages. *Journal of Agricultural and Food Chemistry*, 47, 873–877.

[10]. Hand, L.W, R W. Mandigo and C. R. Calkins, 1992. The effects of preblending time on physical and textural properties of coarse ground sausages. *J. Meat Science*. 31: 13-24.

[11]. Harford, J.J., M.W. Chew, J.M. Squire, and .E.T. Andrews, 1991. Crossbridge States in Isometrically contracting fish muscle: Evidence for swinging of myosin heads on actin. *Adv. Biophys.* 27: 45-61.

[12]. Hughes, M. C., Kerry, J. P., Arendt, E. K., Kenneally, P. M.,McSweeney, P. L. H., and O- Neill, E. E., 2001. Characterization of proteolysis during the ripening of semi dry fermented sausages. *Meat Science*, 62: 205–216.

[13]. Jeacocke, R.E. (1977). The temperature dependence of anaerobic glycolysis in beef muscle held in a linear temperature gradient. *J. Sci. Food Agric.* 28, 55.

[14]. Joandel, S., C. Boyer, A. Ouali and J. Culioli, 1994: Heat gelling properties of myofibrillar proteins: influence of various contaminants, muscle type and medium conditions. Surimi Technology from Poultry, Red Meat and Fish. Dep. Food Sci. and Technol. The Agricultural University of Poznan: 59–77.

[15]. Katsaras, K., and K.D. Budras., 1992. Microstructure of Fermented Sausage. *J. Meat Science* 31:121-134.

[16]. Kimura, S., and Ohno, Y., 1987. Fish type I collagen: Tissue specifc existence of two molecular forms, (a1)2a2 and a1a2a3 in Alaska pollack. *J. Comp. Biochem. and Physiology,* 88B(2): 409–413.

[17]. Kuo, CC and C.Y. Chu, 2002. Quality characteristics of Chinese sausages made from PSE pork. *Meat Science* 64:441–449.

[18]. Laack, V.R. L. J. M., and Kauffman, R. G., 1999. Glycolytic potential of red, soft, exudative pork longissimus muscle. *Journal of Animal Science,* 77: 2971–2973.

[19]. Lenah. 1995. *Ringkasan Pembuatan Bakso dan Sosis Dari Bahan Dasar Daging Ikan Cucut Hasil Pemasakan Ekstruksi Serta Evaluasi Mutunya.* Fakultas Teknologi Pertanian. Institut Pertanian Bogor. Unpublised. Bogor.

[20]. Lien, R., Hunt, M. C., Anderson, S., Kropf, D. H., Loughin, T. M., Dikeman, M. E., and Velazco, J. (2002). *Journal of Food Science,* 67, 1007–1010.

[21]. Moreno, P.M. J., P. lvarez, J. A., Barbera, M. E., Gago-Gago, M. A., Rodriguez L.A., and Ballester, A., 1992. *Chorizo: color parameters evolution during ripening.* In 38th International congress of meat science and technology. France. Clermont-Ferrand. 563-566.

[22]. Morioka, K. and Y. Shimizu, 1992: *Heat gelling properties of fish sarcoplasmic protein.* Nippon Suisan Gakkaishi 58, 767–770.

[23]. Morita, J., J. Ichiro, J. S. Choe, K. Yamamoto, K. Samejima and T. Yasui, 1987: Heat inducedgelation of myosin from leg and breast muscles of chicken. *Agric. Biol. Chem.* 51:2895–2900.

[24]. Nursyam H, S.B. Widjanarko, Sukoso dan Yunianta, 2007. Processing of African Catfish Fermented Sausage Using a *Pediococcus acidilactici* 0110 <TAT-1 Culture Starter at Different NACL Levels against Quality. *Jurnal Agritek.* 15(3): 558- 565.

[25]. Okada,M., 1992. History of Surimi Technology in Japan. Kangawa, Japan: Suzuhiro Kamaboko Kogyo Company Ltd. . 66(4):188 – 192.

[26]. Ramírez, J.A., Martín-Polo, M.O. and Bandmand, E. 2000. Fish myosin aggregation as affected by freezing and initial physical state. *J. Food Sci.* 65: 556-660.

[27]. Rossa, M., and Incze, K. ,1990. Fermented sausages. Food Reviews International, 6, 91–118.

[28]. Rose, C., and A. B. Mandal , 1996. The interaction of sodium dodecyl sulfate and urea with catfish collagen solutions in acetate buffer: hydrodynamic and thermodynamic studies. *International Journal of Biological Macromolecules* 18: 41-53.

[29]. Smith, D.M. 1988. Meat proteins: Functional properties in comminuted meat products. *Food Technol*. 42(4): 116-121.

[30]. Suzuki,T. 1982. Fish and Krill Protein Processing Technology. *pplied Science Publications Ltd,* London.

[31]. Theno, D.M., Siegel D.G., Schmidt G.R., 1978. Meat massaging: effects of salt and phosphates on the ultrastructural composition of cured porcine muscle. *J. Food Sci*. 43: 3327-330.

[32]. Winarno, 2004. Food, nutrition, Technoogy and consumer. *Gramedia Pustaka Utama*. Jakarta-Indonesia..

[33]. Visessanguan, W., Benjakul, S. and An, H., 2000. Porcine plasma proteins as a surimiprotease inhibitor: Effect on actomyosin gelation. *J. Food Sci.* 65: 607-611.

[34]. Woloszyn, J., 2002. The functional properties of muscles from force-fed Mulard ducks. Part I: The gelling properties of muscle proteins. *Gelierende Eigenschaften derMuskelproteine*